Free Communications, Oral Presentations: Mild Head Injury

Saturday, July 1, 9:45AM-11:00AM, Cleveland B; Moderator: Kevin M. Guskiewicz, PhD, ATC

The Effect Of Continued Activity Following Concussion

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Recently there has been an increased awareness in the evaluation of concussion in sports. Current literature supports the use of neuropsychological and balance testing to be used as part of the clinical evaluation and in making return to play decisions. Recent evidence suggests significant short term neurocognitive deficits following concussion which may last a few seconds to several days. The challenge for clinicians is to accurately assess the injury and determine if the athlete can return to participation. However, the short term effects of returning an athlete to participation following an injury have not been investigated. The purpose of this study was to compare athletes who continued to play immediate following their injury to those athletes who did not return to play. **Methods** Baseline tests consisting of neuropsychological tests to include the Hopkins Verbal Learning Test (HVLT), Trails A and B, Symbol Digit Modality Test (SDMT), Digits Forward and Backward and Controlled Oral Word Association Test (COWAT). Ten athletes were diagnosed with a Grade I or Grade II concussion by a physician using the American Academy of Neurology scale was selected for comparison. Five injured athletes were either cleared by a physician to return to sport participation immediately (< 15 minutes) post-injury or reported their injury post game/practice. For comparison purposes, these athletes were matched to 5 other athletes not immediately cleared to return to play and did not participate in the remainder of the game/practice. The matching criteria were injury severity and SAT score. All athletes were tested serially on day 1, day 2 and day 3 post-injury. A 2 (returned vs not returned) x 4 (day) MANOVA was performed to compare the groups. **Results** For those athletes who returned to participation, they had significantly higher scores for self-reported concussion symptoms (p=.004), lower HVLT scores (p=.011), and lower SDMT scores (p=.032) compared to the not returned group during the course of recovery. **Conclusions** The results suggest different rates of recovery for MTBI between the groups. The returned group demonstrated increased symptoms of post concussion symptoms and deficits in short term memory and executive function. Previous research has shown that the delay in recovery could be due to the increased use of glycogen during the immediate post-injury exercise period which may lead to delayed healing and slower recovery from the injury.

Relationships Among A Standardized Measure For Concussion, Postural Stability, And Function In Non-Injured Athletes

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The purpose of this study was to establish normative data for examining the relationships among the Standardized Assessment for Concussion (SAC) instrument, postural stability using the Biodex Stability System (BSS) and dynamic balance using a single-plane balance board (SPBB). Sixty Temple University football players (age = $21.06 \pm .22$ yr, wt = 103.04 ± 5.50 kg, ht = $186 \pm .36$ cm) volunteered to participate in this study prior to the 1998 football season. Subjects reported for a total of two testing sessions (familiarization and testing). Subjects completed the SAC and performed two postural stability tests (using the BSS and SPBB) and a functional test consisting of a single-leg hop for distance test. The results demonstrate that dynamic postural stability scores (BSS and SPBB) were not strongly correlated with the SAC and the SLH for distance test. The strongest relationships were between the indexes of postural stability. The stability index (SI), as measured with the BSS; is a composite of anterior/posterior and medial/lateral sway. The SI was strongly related to the anterior/posterior index (API) (r = .95) and the medial/lateral index (MLI) (r = .89). Postural stability scores measured via the BSS were poorly related to balance scores using the SPBB (r = .00 to .02). There was a significant inverse relationship between SPBB anterior/posterior total touches and the SLH for distance test (r = -.37, p $\leq$ .05). The relationship between the SI and SAC and SLH were r = -.18 and r = -.24, respectively. There was a significant inverse relationship between the SAC and SPBB anterior/posterior and the medial/lateral total touches (r = -.07 and r = .02, p$\leq$.05, respectively). There was a significant correlation between anterior/posterior total touches (A/Ptot) and medial/lateral total touches (M/Ltot) (r = .29, p $\leq$ .05) as assessed with the SPBB. The findings demonstrated that there was little correlation among the standardized assessment for concussion, postural stability, and functional ability in a non-injured population. Subjects in this study were uninjured and variance among this group was small. It remains to be seen if similar results will be attained in a cognitively or neurologically injured subjects.

Symptomatology Following Cerebral Concussion And Its Relationship With Neuropsychological And Postural Stability Tests

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Clinicians regularly assess concussion according to the symptoms that athletes manifest at the time of injury. Recently, cognition and postural stability have been studied following concussion, however, there is little understanding of how these measures are related to symptomatology. The purpose of this study was to examine the relationship between concussion symptomatology and the measures of cognition and postural stability following injury. Sixteen male and four female Division I athletes who sustained a sport-related concussion participated in this study. All subjects had been previously baseline tested for cognition and postural stability. The postural stability protocol consisted of the NeuroCom Smart Balance Master's Sensory Organization Test (SOT) and a clinical balance test called the Balance Error Scoring System. The cognitive tests consisted of the Trail Making B Test, Controlled Oral Word Association Test, STROOP Color Word Test-3, Hopkins Verbal Learning Test, Symbol Digit Modality Test, and Digit Span Test. Data was collected for each of the variables on days 1, 2, and 3 post-injury. A 16-item symptom checklist was administered at the time of injury, and at each of the three post-injury days. A repeated measures ANOVA for overall symptom severity (accumulation of severity score, 0-6, for all 16 symptoms) revealed a significant difference between time of injury and each of the three subsequent days post-injury (p<.05). Additionally, there was a significant reduction in symptom severity across each successive post-injury day (p<.05). Results of repeated measures ANOVA for each of the four neuropsychological and two postural stability tests revealed similar trends beginning with pre-season baseline testing through day 3 post-injury. The most interesting finding is that multiple regression analyses revealed no significant combination of variables that best predicted the symptom severity on post-injury days 1 and 2 ($R2$=.45 and $R2$=.39 respectively; p>.05). As the symptoms resolved at day 3, the combination of Digit Span, Trail Making B, and SOT explained a significant amount of the variance in symptom severity ($R2$=.64; p<.01). Additional day 1 post-injury regression analysis performed specifically on dizziness severity could not be predicted from the balance measurements ($R2$=.03; p>.05), nor could the symptom score for headache severity be predicted from any combination of the neuropsychological tests ($R2$ =.41; p>.05). The clinical significance of these findings is that although symptom severity, cognition, and postural stability are all affected initially following concussion, they are not necessarily related. Clinicians should therefore use a combination of these evaluation tools when managing concussion.

Predicting The Development Of Post Concussion Syndrome From Initial Signs And Symptoms Following Mild Traumatic Brain Injury

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The purpose of this study was to determine whether the signs and symptoms present during the initial 20 minutes following an episode of mild traumatic brain injury (MTBI) could have predictive qualities with regard to the subsequent development of post concussion syndrome (PCS). All episodes of MTBI that were evaluated by the athletic training room staff from October 1997 through October 1998 were included in the data set. A total of 243 consecutive cases of MTBI were analyzed. The categorical data on the initial signs and symptoms present following an episode of MTBI were collected at 5-minute intervals for 20 minutes following each reported case. Certified athletic trainers, using a standardized protocol for the initial evaluation of MTBI, collected all data. Of the 243 cases of MTBI, 61 (25%) patients developed signs and symptoms of post concussion syndrome while 182 (75%) did not. Proportional hypothesis testing was conducted to determine if there were statistically significant differences between the patients who developed PCS and those who did not for each of the signs and symptoms present during the initial evaluation. Following proportional hypothesis testing, Bayes Theorem, a mathematical modeling technique, was used to compare PCS cases to cases that did not develop PCS in order to identify valid predictors. Several signs and symptoms were identified to be significant predictors of PCS. Results indicate that the presence of amnesia, balance abnormalities, tinnitus, and visual impairments at 20 minutes post injury are statistically significant predictors of PCS. Additionally, based on the available data, patients who had a headache and exhibited signs of amnesia at 5 minutes post injury had an 87% probability of developing PCS. Similarly, patients who reported a headache, dizziness, and exhibited balance abnormalities at 20 minutes post injury had a 73% probability of developing PCS. Based on these data, it may be possible to predict whether athletes that experience an episode of MTBI will develop PCS.

A Comparison Of Concussion Incidence And Recovery In Collegiate Football Players With And Without Previous History Of Concussion

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The incidence of repeated concussions and the long-term sequelae that follows has been a topic of considerable debate in the sports medicine literature. Of recent concern is the effect of previous head injury on the risk of subsequent head injury and post-injury recovery time. The present study was designed to examine these issues as part of a much larger research project on concussion in collegiate football players. Prior to the 1999 football season, 2,470 collegiate football players at 33 NCAA institutions provided a self-reported history of previous concussions sustained within the last eight years. Twenty-two percent of the players reported sustaining at least one previous concussion prior to the 1999 football season and 5.5% reported having sustained two or more previous concussions. A chi-square test of independence performed on 73 players who sustained an injury during the 1999 season revealed a significant difference in occurrence of concussion by those players with and without a prior history of concussion ($c_2 = 9.25$; $p = <.05$). Players who reported a history of concussion experienced a higher incidence compared to those reporting no history of any previous concussions within the last eight years. In addition, we studied 25 of the injured players to determine the effects of previous concussions on symptomatology and cognitive functioning during the week following injury. A 16-item symptom checklist and The Standardized Assessment of Concussion (SAC) were administered at pre-season, and at days 1, 2, 3, 5, and 7 post-injury. A repeated measures ANOVA revealed a significant group x day interaction ($F(5,115) = 2.46$, $p<.05$) for the SAC total score. Post-hoc analyses found that the injured players with a history of concussion demonstrated minimal improvements in SAC scores across test days and did not demonstrate a significant recovery learning effect until day 5 post-injury. In contrast, players who had no history of concussion showed a definitive learning curve and revealed a significant recovery learning effect by day 2 post-injury. Also of note was a lack of significant differences between severity of multiple symptom scores (i.e., headache, nausea, dizziness, etc.) reported by the two groups following injury. The clinical significance of these findings is that collegiate football players with a previous history of concussion appear to be at greater risk for recurrent injury and lengthier post-injury recovery time compared to those with no history of concussion. Additionally, the severity of symptoms does not always explain the entire status of a concussed athlete.